



# IEDs in the Context of Appropriate Technology

ROBERT L. FELDMAN, LTC, USAR

**The Foreign Military Studies Office (FMSO)** at Fort Leavenworth, Kansas, is an open source research organization of the U.S. Army. It was founded in 1986 as an innovative program that brought together military specialists and civilian academics to focus on military and security topics derived from unclassified, foreign media. Today FMSO maintains this research tradition of special insight and highly collaborative work by conducting unclassified research on foreign perspectives of defense and security issues that are understudied or unconsidered.

### **Author Background**

Robert L Feldman, LTC, USAR, is an Africa analyst and the Africa Team Leader with the Foreign Military Studies Office, Fort Leavenworth, KS. His areas of interest include terrorism, counterterrorism, and human security in Africa. He has published in numerous peer-reviewed journals and has served as a subject matter expert at various DoD functions.



---

FMSO has provided some editing, format, and graphics to this paper to conform to organizational standards. Academic conventions, source referencing, and citation style are those of the author.

The views expressed are those of the author and do not represent the official policy or position of the Department of the Army, Department of Defense, or the U.S. government.

# **IEDs in the Context of Appropriate Technology**

**Robert L. Feldman, LTC, USAR**  
**Foreign Military Studies Office**  
**Fort Leavenworth, KS**

**17 February 2015**

The American military, which pours billions of dollars into high tech research and development of its vehicles, has at times found itself struggling against relatively inexpensive and frequently unsophisticated homemade bombs known as improvised explosive devices, IEDs. These weapons have been responsible for the majority of NATO troop deaths in both Afghanistan and Iraq.<sup>i</sup> It is almost as if the United States did not suspect such artisanal weapons were going to be used, or if they were that the evolutionary pace of countermeasures would exceed that of IED modifications. Perhaps a closer look at the context within which IEDs develop, appropriate technology, could shed light on ways to counteract them.

What exactly is meant by "appropriate technology?" Unfortunately there are numerous interpretations of the term, making a precise definition universally accepted by all rather unlikely. To an extent it can be thought of as the products, and/or the movement to make such products; created with a community's technical, environmental, financial, social, political and other needs in mind; and frequently using locally available materials and labor-intensive as opposed to capital-intensive techniques.<sup>ii</sup> These small-scale operations generally do not require a high level of education, making them valuable for less developed countries, particularly at the village and rural levels. Foot-operated treadle pumps for irrigation, solar cookers and a host of other appropriate technologies are improving the lives of countless individuals.

By examining how previous examples of appropriate technology in a country of military interest were developed and distributed, valuable insights into what to expect in the realm of IED development and distribution might be obtained. As an example, take solar ovens, also known as solar cookers, usually about the size of a large breadbox which use the sun's energy to cook food. These devices, of which there are numerous designs ranging from dark pots with glass coverings to fairly sophisticated apparatuses incorporating parabolic reflectors, have proven to be a

tremendous boon to villagers, especially women who are often tasked with collecting firewood. In so doing they help prevent deforestation and since some can boil water, assist in limiting the spread of water-borne illnesses. Prior to or shortly after initiating operations in a country the US military could look at these solar cookers and, in order to develop a better of how IEDs might be developed and dispersed, ask the following questions:

- What materials are required to make these ovens?
- If any materials are required from other places how are they brought to the village?
- Who are the village artisans creating the ovens?
- Is there community involvement in making the ovens?
- How is the construction of these ovens financed?
- How are these ovens distributed?
- How has the technology to make these ovens been dispersed to other regions?
- How have the ovens evolved over time?
- Who are the early adopters of the ovens and who are more hesitant regarding new technologies?
- Are there areas where the new ovens were introduced, took hold, but later were abandoned? If so, why?
- What aspects of village life changed with the introduction of the ovens?

Using this information on solar ovens it might be possible to glean some clues as to what type of IEDs could be expected, who would build them, and what factors will be involved in their evolution and dispersion. By combining this knowledge with information gathered from other sources, a more complete picture of potential IED threats could emerge, and perhaps, in turn, even countermeasures.

### Further Defining Appropriate Technology

To many the use of certain high technology devices can still be considered appropriate technology. An example of this would be using solar cells to generate electricity for a remote site. Expanding the list of appropriate technologies even further might include not just products but also techniques such as fish farming. Thus, one can see a specific definition of appropriate technology can be difficult to formulate, and depending on who is doing the defining, the list of what is included can be narrowed or broadened.

Along these lines of defining appropriate technology, many would include the requirement that it be used for the betterment of the local population and/or peaceful means, making the inclusion of IED' problematic. However, it could be argued from the perspective of Iraqi and Afghan insurgents that they are using IEDs to better the conditions of the local population by forcing occupying forces out of their country. This, in turn, will result in peace. Thus, in this view it could be considered an appropriate use of technology, incorporating all of the other typical characteristics such as being inexpensive and labor-intensive. Much as one man's terrorist is another man's freedom fighter, definitions depend upon who is doing the defining.

### Gandhi and Schumacher: The Origins of Appropriate Technology

One might be surprised to find Mahatma Gandhi, whose name is almost synonymous with nonviolence, as utilizing appropriate technology to resist occupation. Though Gandhi did not use the phrase appropriate technology, his descriptions of the Indian village use of devices such as the spinning wheel and bicycle fit the definition. This seeming paradox of a man of peace using technologies to resist occupation is resolved by examining how he encouraged them to be used.

Almost with religious enthusiasm, Gandhi embraced the philosophy of employing inexpensive, labor-intensive devices to both empower the Indian people and undermine the British economically. He did not start the economic boycott of British products and the revival of domestic-made ones, known as the Swadeshi movement, in India.<sup>iii</sup> Instead his contribution was to push for the production of khadi, homespun cloth, using the charkha, a type of spinning wheel which would become a symbol of the independence movement.<sup>iv</sup> This act of civil disobedience with an appropriate technology helped India gain its freedom from British rule in 1947. To think the once mighty British Empire had been defeated in part by a spinning wheel is quite remarkable.

About 25 years after Gandhi used the charkha to help free India, a collection of essays written by a British economist, E.F. Schumacher, heavily influenced by Gandhi's philosophy on technology was published.<sup>v</sup> "Small is Beautiful: Economics as if People Mattered" was ranked as one of the 100 most influential books to have been written since World War II.<sup>vi</sup> Opposed to the tenets of neoclassical economics, which he found dehumanizing, Schumacher emphasized the workplace should be dignified and meaningful. Among his many other thoughts he felt large organizations would do well to decentralize, acting as a group of small organizations, and that the philosophy emphasizing ever larger production is wrong. Though he didn't coin the term "appropriate technology," publication of his book is often looked upon as one of the founding moments of the movement. Interestingly, he also didn't coin the term "Small is Beautiful," though it's often ascribed to him. It came from a phrase used by his teacher, the Austrian philosopher and economist Leopold Kohr.<sup>vii</sup>

IED fabrication in Iraq and Afghanistan seem to incorporate many of Schumacher's concepts: decentralized organization, meaningful work, small scale production, and other aspects of

economics and technology described in "Small is Beautiful." This idea will be further explored in the next section.

### IEDs as Appropriate Technology

As there is no universal definition of appropriate technology, a single checklist to see if a technology fulfills the criteria to be designated an "appropriate technology" is not going to meet everyone's standards. However, the below list, essentially an amalgam of several articles describing appropriate technology, captures many of the main points.

While looking at the checklist for what might be considered appropriate technology, notice how the IED, like the Indian spinning wheel, the charkha, fulfills the requirements. Here is the list:

- Inexpensive. Although there are some exceptions, most IEDs are relatively inexpensive. Considering that the populations making them in Iraq and Afghanistan are often quite poor this should come as no surprise. However, there is another definition of inexpensive besides the absolute cost in Iraqi dinars or Afghan afghanis. IEDs are extremely inexpensive in comparison to American war machines.
- Locally available materials are used. This does not mean the material has to be produced locally, such as wood grown from a nearby forest, but rather that the material is available locally even if it was manufactured someplace else. Thus, artillery rounds which may have been produced in a different country but stolen from a local armory during a period of political turmoil are locally available items. The same is true for gasoline which may have been refined somewhere else and then transported to a local village where it's purchased for use in both trucks and IED construction.

- Labor-intensive. Bearing in mind that in places such as Iraq and Afghanistan where capital is generally difficult to acquire and labor is generally cheap, it would be expected that IEDs are labor-intensive. Thus, high tech manufacturing plants which might be able to reduce the cost per IED produced but would require large upfront capital investments are unlikely to occur in extremely poor regions. This is not to say there won't be assembly lines to make IEDs in Afghanistan, but if there are they will most likely involve people doing the manufacturing as opposed to high-end machines. Additionally, from the standpoint of the IED maker, it's probably good that it's labor-intensive as a modern manufacturing plant would most likely be easier for the Americans to uncover than an individual working in his house. To be clear, IEDs can be produced at an industrial level, and it appears in Pakistan such IED factories exist. The products are then smuggled into Afghanistan for distribution. However, as Americans are limited as to how much they can do in Pakistan, such factories enjoy some protection from US attack. In Afghanistan the story is different, and a factory, especially anything larger than just a few person operation, or one that requires a large amount of electricity to power its equipment, risks being detected where there is an American presence.
- Uses skills already present in the population. Thus, a formal technical education is not required. Many of the requisite skills are already used for other activities, such as repairing broken farming implements. Any additional knowledge required can often be learned from trusted confidantes who are also constructing IEDs.
- A lack of formal education can be a strength. For the locals who construct solar ovens and other such devices, much of their learning is through observing others as well as

trial and error practice. Not to sound facetious, but they aren't hobbled by modern instructional developments which frequently involve more passive listening than active engagement. Thus, they don't have the inhibitions/questions which sometimes come with a formal education.

- There are frequently basic templates or rules to simplify the manufacturing process. Thus, it's not important to know all of the inner workings of a watch such as the electronic principles behind a microprocessor based timer, it's just important to know how to use the timer to make two wires come together so a circuit is completed in order to detonate the IED.
- Often made locally. For IEDs this is quite important as increasing the distance they're transported increases the risk they'll be discovered.
- Village participation to varying degrees. Some appropriate technologies might be manufactured with the involvement of only a very few people, others might require larger numbers of individuals to participate. Perhaps for some IEDs the saying "it takes a village" is true.
- Has the potential to bring communities together. This is especially true if there is a perception that the technology will be beneficial, be it a water pump or IED. Along these lines, there can be pride in their accomplishments; once again be it a water pump or IED.
- Frequently scalable in number required, size, or both. More charkhas for more cloth. More or larger solar cookers. More or larger IEDs.
- Evolving. Villages are often filled with tinkerers, adapting technologies to local use and making improvements when necessary.

- Improvements can be incremental or quite large.
- Information on successes is shared with others. Just as news of a better cook stove in one village will spread to others, the same is true for IEDs.
- Meets a need(s); not created in a vacuum. Why are people making IEDs should be one of the first questions to ask.
- Not always fully understood by outsiders. An IED might be described as crude and primitive without acknowledging the creativity that went into it, underestimating what it took to make it. On the other hand advanced engineering capabilities could be ascribed to villagers when in reality they followed a simple template. Thus, one can say the locals aren't very advanced as the timer was made from a discarded washing machine or one can say the locals are quite advanced, capable of making timers from discarded washing machines. Much depends on the cultural perspective of the viewer as to how he or she interprets the capabilities of the IED makers.
- Regarding key components, substitutions are frequently though not always possible. Along these lines, construction of IEDs could be described as a Chinese menu approach: pick a trigger mechanism from column A, a detonator from column B, and an explosive from column C. If a particular trigger mechanism in column A is no longer available then pick another.
- Generally, though some individuals are more capable than others of building IEDs, no one person is irreplaceable. Thus, targeting individuals may help for only a short period of time.

- There are limits to what can be made. Though villagers can be incredibly inventive, not everything can be locally constructed. Thus, if a more powerful water pump or bomb is required it might have to be imported from elsewhere.

### Mass-produced and Improvised?

At what point is an IED no longer an IED? In other words, does mass-producing an explosive device remove its standing as being "improvised?" This may sound like a semantic exercise but it does have military implications. Applying the criteria of appropriate technology can help answer this question.

An example will help illustrate the case. Some IEDs in Afghanistan originally used two metal saw blades with a spacer between them, attached to a detonator, which in turn was connected to an explosive. When the saw blades were brought together by a force such as a truck rolling over where the IED was buried in the ground, a circuit was completed, causing the device to explode. With the US military using countermeasures such as metal detectors to find IEDs the Afghan rebels looked to replace the metal saw blades. Graphite blades which conduct electricity, but as they are nonmetallic are not detected by metal detectors, proved to be excellent substitutes.<sup>viii</sup> However, this new device is not made by the rebels in Afghanistan, but instead manufactured in Pakistan on what could be considered an industrial scale.

As these devices are no longer constructed in Afghanistan's villages and do not use locally available Afghanistan materials, they do not meet some of the criteria on the checklist for appropriate technology. It calls into question whether "improvised" as in improvised explosive device still applies. Since they are still called IEDs this paper will do so, however as their degree of sophistication grows and the ability of locals to modify them decreases, it could soon be time

to find another term to differentiate these industrial products from homemade devices. There is a certain connotation of IEDs which can be thought of as jerry rigged, innovative with locally available materials, and not produced in a factory; characteristics these devices from Pakistan lack.

Both locally made IEDs and IEDs from Pakistan are deadly. However there are differences in components, as would be expected with many locally made devices compared to those constructed in a factory. As components are one of the key targets for countermeasures, whether an IED was made at the village level using locally available resources - the typical appropriate technology route - or in a factory in another country, will play a role in how American troops combat this deadly scourge.

#### Simple Technologies Can Be More Effective

At first glance it seems paradoxical that the US military, accustomed to the rather sophisticated IEDs that had evolved during their time in Iraq, is having difficulties developing effective countermeasures against IEDs in Afghanistan. After all, in Afghanistan the literacy rate is only in the single digits and there is generally less access to high-grade munitions as compared to Iraq. However, one needs to keep in mind that with appropriate technologies sophisticated does not necessarily mean better.

As an example, a water pump with numerous moving parts which pumps more water from a well than a simpler design might initially sound like it would be the better choice for a rural village. However, its complicated design could mean it's more prone to breakage as well as more difficult to repair when it does. Thus, in considering various local factors, the simpler pump might be the appropriate technological choice for the village.

One way the Afghans have made their IEDs simpler yet more effective than the recent Iraqi IEDs is by using ammonium nitrate instead of conventional military-grade munitions.<sup>ix</sup> In true dual use fashion as often occurs with appropriate technology, ammonium nitrate can be used as a fertilizer or an explosive. That ammonium nitrate can be used as a fertilizer makes restrictions on its possession a bit more complicated. That it can also be used as an explosive, and in fact a variant of it was used in the 1995 attack on the Murrah Federal Building in Oklahoma City, makes it extremely dangerous. Unfortunately for US troops in Afghanistan, unlike Iraqi bombs with their significant metal composition that can be detected by metal detectors, those made with fertilizer are relatively low in metal and thus require different strategies to counteract.

The Afghans did not, as far as this author knows, choose to use less complicated IEDs. It was dictated by the availability of local resources and capabilities of local craftsmen. It has also proven so far to be a successful strategy, and we can expect the evolution of these devices to have both similarities and differences to what occurred in Iraq. This is comparable to what might occur with an appropriate technology, such as a new plow design, being adopted by different countries. Over time each new generation of plows would change, reflecting adaptation to its location. Some of the plows might be relatively complicated compared to other countries, but that would not necessarily make them better, or in other words, provide them with a competitive advantage if they were tested in a different country where a simpler design had evolved. This is also true for IEDs. What works well in Iraq might not work well in Afghanistan even though the Iraqi IEDs are more sophisticated than their Afghanistan counterparts.

## Steps to Combat IEDs Based on Appropriate Technology

Beyond the previously mentioned action of providing a reason to stop producing IEDs, which stability operations, with mixed success, is attempting to do, there are certain steps based on IEDs being appropriate technology that can be implemented to help combat the proliferation of these devices. These are certainly not in themselves going to stop IED production. Also, they are not a substitute for current IED countermeasures presently being used. However, they may provide some benefit, and even if the results are so marginal just one IED is prevented from being constructed and deployed against American troops they are worth considering.

- Recognize the difficulties in a counter-IED strategy that focuses on key components.

Appropriate technology emphasizes flexibility and the use of local resources, whether it's making a spinning wheel or IED. It is doubtful construction can be stopped by removing what authorities think is a key component; most likely it will only be delayed. As an example, a radio controlled improvised explosive device, or RCEID, can incorporate a car alarm, wireless doorbell, cell phone or other item which can be remotely controlled. Thus, trying to limit the incorporation of car alarms in RCIEDs might prove only temporarily successful as there are ready substitutes waiting to be used. It is not that attempting to restrict components isn't worthwhile, but a "key component strategy" should recognize that rarely is there a key component that can't be replaced, and the majority of countermeasure efforts might be better spent elsewhere.

- Be cognizant that new designs, to be modified locally, may originate in other countries.

Thus, a new spinning wheel design may originate in Bangladesh and spread to India where local materials and methods are used to modify it. The same is true for IEDs, where for example a design originally attributable to the IRA finds Palestinians

modifying it for their own use before it's adopted by Iraqis. Therefore it's imperative Americans study IEDs from other regions, as well as from previous wars, to understand what the next iteration may be and possible countermeasures that could potentially be utilized.

- Be extremely cautious in introducing new technologies to benefit the people as these may result in IED modifications. These changes could be the result of direct or indirect use of the new technologies. An example of a direct use would be where cell phones, introduced into a village, are now being used for RCEIDs. An indirect use would be computers with internet access, also introduced into a village, providing schematics on IED designs not previously used in that area. Cell phone and computer technologies, while having the potential to improve a village's economy as well as its participation in a nation's nascent democracy, can also be used in the fight against Americans. It is difficult to imagine any technology that could not be subverted for making IEDs, and thus it is important that Americans look at ways, if they are going to introduce the latest gizmos and gadgets, to reduce the likelihood their attempts to modernize local villages don't have counterproductive results.
- Interrupting funding of IED construction may require different approaches than those used by American authorities against American criminal enterprises. The problem is though generally little money is required for construction of appropriate technologies, when funds are required they might be transferred via traditional village ways. Thus, if money is needed to purchase components for an IED, it might be sent to the village using hawala, a method to transfer funds based on trust.<sup>x</sup> While it has little to no written records, making tracings of payments difficult, there are some countermeasures

available. One should note though that a major use of hawala is for remittances from relatives working in other countries, and that it can be difficult to disentangle the flow of funds for legitimate purposes such as money for school or medicines from that used to purchase timers and explosives.

- Americans should use appropriate technology to their advantage. Providing the designs and initial assistance for improved water pumps, spinning wheels, and other devices can boost a village's health and economy, greatly improving the local people's relationship with Americans.
- As noted at the beginning of this article, before entering a country it would be useful to determine ahead of time what types of IEDs might be constructed based on appropriate technologies that have already been developed and/or used there. Look at individual countries, especially ones of military interest, to see how cultural, political, economic and other factors influence appropriate technology, sometimes in quite nuanced ways, to meet local needs.
- If possible, talk with people who were involved in appropriate technology development and dispersion in the country of interest. This could mean asking for help from NGO's, some of which have not traditionally been enamored, to put it mildly, with the military. However, as the relationship between the military and NGO's is continually evolving, and with the knowledge that better understanding the development and dispersion of appropriate technologies in the country could result in more effective countermeasures against IEDs that save American lives, such discussions might be possible.
- Decide what is and isn't negotiable. Perhaps the Indians would have been willing to delay using the charkha in large numbers and spinning their own cloth, thus still having to

purchase British cloth, in exchange for a promise of independence on a certain date. Both sides would have had to make difficult concessions over this appropriate technology. Americans may also need to decide what is negotiable to make an appropriate technology related to a struggle against a foreign occupier go away, though the ethical and practical questions in deciding where to compromise in order to lessen the resistance against American forces can be mind numbing.

### Conclusion

Some almost appear as Rube Goldberg like contraptions, with saw blades, plastic gasoline cans, and other components strung together with tape and dangling wires. However, despite their often crude appearance, IEDs are quite deadly, and the US military is constantly searching for new countermeasures against them. Looking at locally crafted devices such as solar cookers whose construction is labor-intensive - what are known as appropriate technologies - can provide important clues as to the development and dispersion of IEDs in that country. It is not the entire solution to combating this scourge of American fighting troops, but rather a small yet critical piece of the puzzle.

Were Gandhi and Schumacher alive today they would almost certainly object to including IEDs as appropriate technologies. They looked at ways to bring peace and environmental sustainability to the world, not suffering. Yet, it's hard to ignore that many of the other principles, such as labor-intensive and locally crafted, fit today's IEDs. Perhaps with regards to IEDs it's time for a new book to be written, "Small Is Not Always Beautiful."

## Disclaimer

The views expressed in FMSO publications and reports are those of the authors and do not necessarily represent the official policy or position of the Department of the Army, Department of Defense, or the U.S. Government.

## Notes

---

<sup>i</sup> DoD Personnel and Procurement Statistics: Casualty Summary by Reason Code. Prepared by Defense Manpower Data Center. 7 Feb 2011

<sup>ii</sup> Gerald Meier, *Leading issues in Economic Development* (New York: Oxford University Press, 1989), 268-272.

<sup>iii</sup> Lisa Trivedi, *Clothing Gandhi's Nation* (Bloomington, IN: Indiana University Press, 2007), 34-36.

<sup>iv</sup> *Ibid.*, 6-17.

<sup>v</sup> E.F. Schumacher, *Small is Beautiful: Economics as if People Mattered* (London: Perennial Library/Harper and Row, 1975)

<sup>vi</sup> *The Times Literary Supplement* (London: Times Newspapers, Oct 6, 1995), 39.

<sup>vii</sup> *Dr. Leopold Kohr, 84; Backed Smaller States* (New York: New York Times, Feb 28, 1994).

<sup>viii</sup> Andrew Johnson, "Taliban Make "Undetectable" Bombs Out of Wood," *The Independent* (Jan 10, 2010), <http://www.independent.co.uk/news/world/asia/taliban-make-undetectable-bombs-out-of-wood-1863353.html> (accessed Feb 10, 2011).

<sup>ix</sup> Anna Mulrine, "Afghanistan War, Why IEDs Are Taking a Mounting Toll," *The Christian Science Monitor* (Dec 7, 2010), <http://www.csmonitor.com/USA/Military/2010/1207/Afghanistan-war-why-IEDs-are-taking-a-mounting-toll> (accessed Feb 10, 2011).

<sup>x</sup> Robert Feldman, "Fund Transfers - African Terrorists Blend Old and new: Hawala and Satellite Telecommunications," *Small Wars and insurgencies* 17, no. 3 (Sep 2006): 356-366.